Refer to: Buck BA: Ancient technology in contemporary surgery (Information). West J Med 136:265-269, Mar 1982

Information

Ancient Technology in Contemporary Surgery

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Archaeologists have shown that ancient man developed the ability to produce cutting blades of an extreme degree of sharpness from volcanic glass. The finest of these prismatic blades were produced in Mesoamerica about 2,500 years ago. The technique of production of these blades was rediscovered 12 years ago by Dr. Don Crabtree, who suggested possible uses for the blades in modern surgery. Blades produced by Dr. Crabtree have been used in experimental microsurgery with excellent results. Animal experiments have shown the tensile strength of obsidian produced wounds to be equal to or greater than that of wounds produced by steel scalpels after 14 days of healing. We have been able to demonstrate neither flaking of glass blades into the wounds nor any foreign body reaction in healed wounds. Skin incisions in human patients have likewise healed well without complications.

The prismatic glass blade is infinitely sharper than a honed steel edge, and these blades can be produced in a wide variety of shapes and sizes. It is therefore suggested that this type of blade may find an appropriate use in special areas of modern surgery.

TWELVE YEARS AGO a technique was developed that allowed the manufacture of knife blades infinitely sharper than those in current surgical use. In these days of rapidly advancing technology, this fact might be of no more than passing interest. What is of interest, however, is the fact that this "new" technology of blade manufacture was but a rediscovery of a technique practiced up to 1 million years ago by ancient man. The material from which these blades were formed was stone. This article will attempt to trace the rediscovery of these remarkable cutting instruments, postulate ancient uses and perhaps suggest a place for this technology in the practice of contemporary surgery.

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History

We are all familiar with the stone instruments made for many centuries by cultures the world over before the availability of metals. These instruments range from the crude scrapers of 3 million years ago to exquisite spear points and arrowheads, which date from 14,000 years ago into the early 1900's in North America. Until very recently, many myths and mysteries have shrouded the method of manufacture of these artifacts. The first opportunity to learn sophisticated flint-knapping (the manufacture of tools

from stone) from a "stone-age man" came in 1911, when a starving Indian presented himself to civilization in Northern California.[1] Fortunately, he was befriended by Professors Waterman, Kroeber and Gibson of the University of California Anthropology Department, and his techniques of flint-knapping were carefully studied. During this same era, others were attempting to duplicate the varying ancient technologies that had produced different types of instruments in Northern America and elsewhere in the world.[2,3] Ishi, the last "wild Indian," died in the University of California Museum in San Francisco in 1916. Twenty years later, Professors Kroeber and Gibson had an assistant named Don Crabtree working in their lithic laboratory. He was pursuing an interest in lithic technology that began when he was a child collecting artifacts near his Southern Idaho home. Largely self-taught, he developed a skill in the art of flint-knapping which few have matched. His major contributions, however, were the result of his approach to this science and art. He became one of the world's primary authorities on experimental archaeology.[4] His scholarly study of stone artifacts proceeded through a logical deductive process to a rediscovery of the ancient techniques used to produce them. He was therefore able to duplicate for the first time many of the feats of ancient man. Indeed, Professor Bordes of Université de Bordeaux, suggested that American archaeology be divided into pre-Crabtree and post-Crabtree periods. Though Dr. Crabtree traveled widely in his later years, he maintained his residence near Kimberly, Idaho, and accomplished most of his experimental work in his home laboratory.

Despite the use of many natural materials and varying technology worldwide, the irregular flaked edge is the hallmark of those artifacts with which we are all familiar. There exists, however, an entirely different facet of lithic technology which is less well known. This technology consists of the ability to remove a long (up to 12-inch), extremely sharp blade from a core of obsidian (volcanic glass) in a single maneuver. The resulting blade is basically flat and triangular or trapezoidal in cross section (Figures 1 and 2). The glass blade can be produced in many shapes and sizes. These blades differ from the familiar spear point in that the cutting edge is absolutely straight, and is formed by a single fracture line. The two parallel cutting edges are extremely sharp, the edges themselves measuring approximately 30 angstroms in thickness. The comparison between this edge and that of a new razor blade is shown in Figure 3. At a magnification of 10,000 times, the razor blade edge appears essentially flat, whereas the edge of the glass blade remains a definite sharp angle. Similar types of blades, and the "cores" from which they were detached, have been found in archaeological sites in France dating back 35,000 to 1 million years.[5] This type of blade is also attributed to the Northwest Indians of North America, and was described by Ishi, the "wild Indian" of Northern California. The high point of this technology, producing thin pressure-flaked blades, was reached in Mesoamerica, where it was perfected approximately 2,500 years ago. These blades were described three centuries ago by the early Spaniards of Mexico and Guatemala. Indeed, there is mention of the Aztecs shaving the Spaniards with similar instruments.[6]

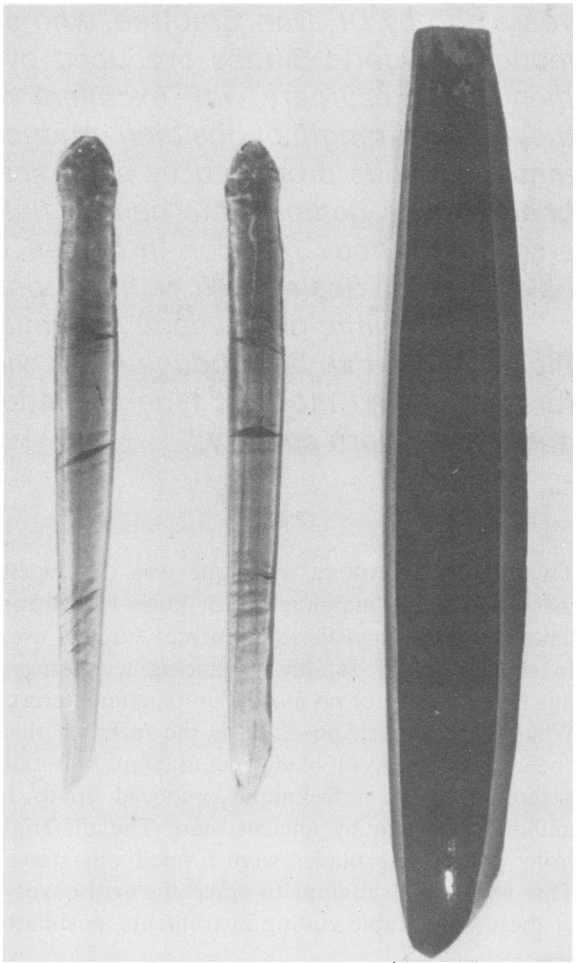

Figure 1.—Prismatic blades produced by Dr. Crabtree. Shown with obsidian "core" found in archaeologic site in Mesoamerica.

Stone artifacts of course do not deteriorate, and are found in abundance in the oldest archaeologic sites. Pottery is less durable, and bone even less so. Nonetheless, definite evidence for bone surgical procedures (amputation, trephination) has been discovered in Neolithic sites.[7,8] However, the form and condition of soft tissue at the time of death can only be a subject of conjecture years later. Therefore, though the availability in ancient times of instruments capable of soft tissue surgical operations is now well established, the uses to which these instruments were put can only be inferred. Undoubtedly, they were used for practical, religious and decorative purposes. There are many accounts of scarification among American Indians well into the last century. This practice is also widely distributed among the primitive tribes of the world today. Since the Aztecs (1,300

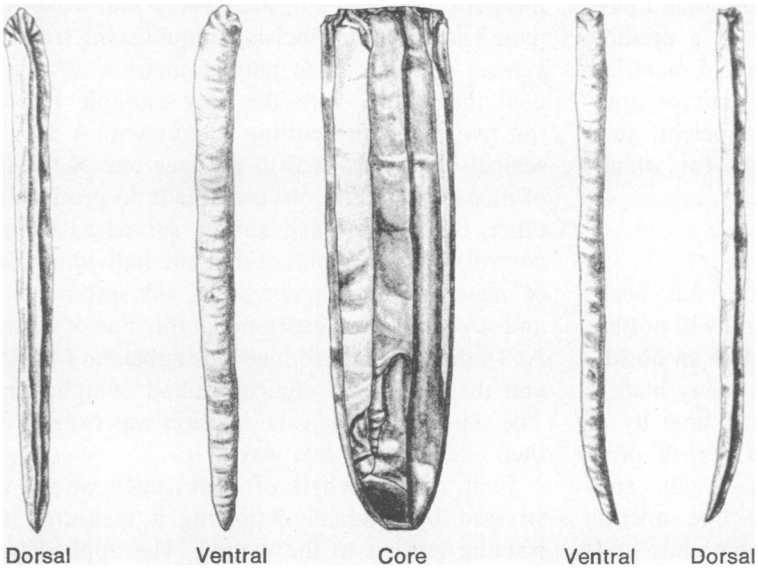

Figure 2.—Diagrammatic representation of obsidian "core," and blades produced from this core. (Courtesy Idaho State University.)

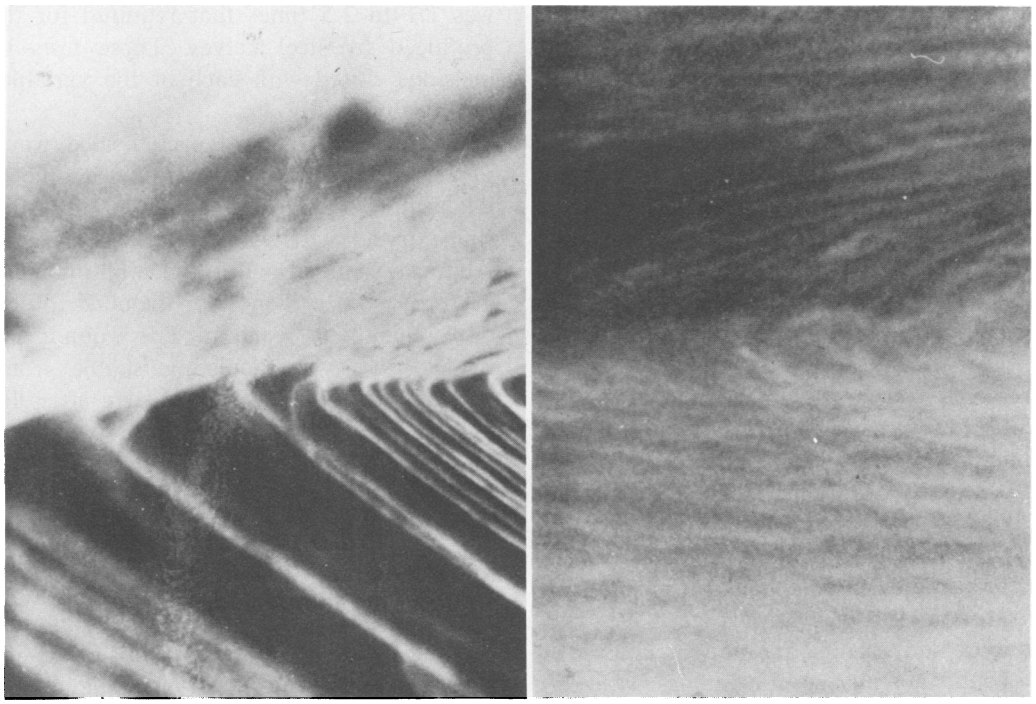

Figure 3.—**Left,** edge of prismatic glass blade. **Right,** edge of new stainless steel razor blade. Both edges are magnified 10,000 times by scanning electron microscope. (Courtesy of Anderson Pace.)

to 1,500 AD) are known to have possessed the finest obsidian instruments, and are also known to have practiced human sacrifice as a religious rite, it is probable that they used obsidian blades to accomplish the donor portion of the modern heart transplant procedure. Whether or not attempts at curative surgical procedures followed the availability of suitable instruments is, of course, difficult to prove. Ongoing studies by Semenov[9] may soon shed some light on this question. He and his co-workers have shown that obsidian knife edges are deformed microscopically in a predictable fashion, depending upon the type of material that has been cut by the blade. This microscopic "fingerprinting" of blades found in ancient sites may one day elucidate the purposes for which these knives were used.

Materials and Methods

The production of obsidian blades has been superbly described by Crabtree[10-14] and will not be detailed here. Meticulous preparation of an obsidian core is required, following which many blades can be produced in a relatively short time by a worker with the requisite skill. Dr. Crabtree produced blades up to 12 inches in length, and experimentally produced extremely fine microblades from obsidian, other lithic materials and many types of commercial glass.

Dr. Crabtree suggested in 1968 that modern surgeons might well look to glass blades for certain procedures.[15] He suggested, however, that "the surgeon who pioneers the use of such blades may be accused of reverting to caveman tactics." When faced with a surgical procedure himself in 1975, he convinced us to try an obsidian blade for the skin incision. Half of the incision was made with obsidian, and half with a standard No. 10 surgical scalpel. The obsidian knife was indeed sharper, and healing of the two extremities of the incision was identical. Several subsequent surgical procedures on physician volunteers scheduled for elective procedures have similarly produced normal healing and no complications. Because of the theoretic possibility of flaking of the stone blades, thereby leaving foreign material in the wound, these instruments have not been used on tissues other than skin and subcutaneous fat in humans in our institution.

In order to address the question of comparability of wound healing, several studies with experimental animals have been carried out. Our initial studies involved skin incisions, microvascular anastomoses and peripheral nerve incisions with prismatic glass blades. These procedures were carried out on anesthetized rabbits under 10 to 25 power magnification. The glass instruments did these functions admirably, and we could find no problems with wound healing in these animals.

A second group of experiments involved the examination of healed skin incisions made on the ventral surface of rabbits. A series of 2 to 3 cm incisions were made in such a way that there were paired longitudinal incisions equidistant from the ventral midline. Each pair of incisions was handled identically, with the only variable between the two being the cutting instrument. A No. 15 scalpel blade was used to produce one of the pair of incisions, and an obsidian blade to produce the other. Therefore, each animal served as its own control. The variables tested on individual pairs of incisions were staple closure, silk suture closure and subcutaneous hematoma at the time of closure. At 14 days the healed incisions appeared identical, and there were no clinical wound complications. The skin containing each incision was excised and then examined in two ways.

First, a 1 cm length of each healed wound was stressed by gradually applying a measured distracting tension to the wound. The applied force required to dehisce the obsidian-produced scars was 1.1 to 2.5 times that required for the scars produced by steel knives. These tests included incisions closed with each of the variables mentioned above.

Second, a portion of each healed wound was processed for examination of microscopic sections. All sections were evaluated in a blind fashion by a single pathologist. After 14 days of healing, all sections examined had a thin, well-organized scar. There was no evidence for included foreign body or foreign body reaction. The wounds produced by obsidian were indistinguishable from those produced by the honed steel edge after this healing period.

Discussion

The evolution of surgical instrumentation has always been of interest to those of us engaged in the field of surgery. Our concept of this evolution traditionally has been concerned with the period of time covered by recorded history, and therefore has concerned itself with the evolution of metal instruments. Archaeologists, however, have now shown us conclusively that stone cutting

blades of a quality equal to and surpassing that of steel blades in common usage today were available to ancient man up to a million years ago. The uses to which these remarkable blades were put is largely conjecture, since procedures upon soft tissue, animal and human, do not leave a record for us. However, there is direct evidence that such blades were used for ceremonial purposes (scarification) in North America, and that they were used for shaving in Mesoamerica. It does not seem unreasonable to assume that, during 1 million years of experimentation, these instruments might have been used to cut human tissue in an attempt to cure.

The recent advent of experimental archaeology has now provided us with the ability to reproduce products of the acme of ancient lithic arts. We once again have access to glass blades of infinite variety, and extreme sharpness. Though experimental work to date is limited, we feel that these blades, properly used, are safe for surgical procedures in humans.

In most fields of surgery, of course, a modicum of sharpness suffices, and one feels comfortable with the convenience of the modern disposable steel blade. However, in many specialized areas, scalpel blades and razor blades leave much to be desired. Examples that come to mind are the debridement of nerve ends for repair, microvascular surgery, fine plastic work on thin skin (blepharoplasty, for example) and ophthalmologic surgery. Though one with faith in modern technology cannot imagine that instruments equal to these various tasks cannot be produced today, the fact remains that no honed metal edge has matched that of the glass blade to date. Also, it is probable that production of prismatic glass blades, using minor modifications of ancient techniques, will be cheaper than the attempt at duplication of these cutting edges in steel. Our initial animal work in microscopic surgery with glass blades made by Dr. Crabtree leads us to feel that this is an area that should be further explored.

Conclusion

It is of historical interest to note that ancient man in several areas of the world had access to cutting blades of volcanic glass which were sharper than the surgical instruments of today. It is also postulated, though it has not yet been proved, that these instruments might have helped to initiate the field of surgical treatment. Experimental archaeology has shown us how to reproduce these blades, and initial animal experimention leads us to believe that they are safe in surgical use. In the near future it may be shown that there is a place in the modern surgical armamentarium for this descendant of ancient lithic technology.

REFERENCES

1. Kroeber T: Ishi in Two Worlds. Berkeley and Los Angeles, University of California Press, 1981

2. Wilson T: Arrowheads, spearheads and knives of prehistoric times. Report of US National Museum for 1897, 1899, pp 811-988

3. Holmes WH: Handbook of Aboriginal American Antiquities, Part I: Introductory—The Lithic Industries. Bur Am Ethnology Bull 1919; 60

4. Crabtree DE: Man's oldest craft revisited. Curator 1970; XIII: 179-198

5. Bordes F, Crabtree DE: The corbaic blade technique and other experiments. Tebiwa 1969; 12:1-21

6. McCurdy GG: The obsidian razor of the Aztecs. Am Anthropol 1900 Menasha; 2:417-421

7. Bick EM: The Classic Source Book of Orthopedics: Primitive Man and Ancient Practice. Clin Orthop 1979 Mar-Apr; 139: 2-16

8. Candis RF, et al: Prehistoric trephination of the frontal sinus. Ann Otol Rhinol Laryngol 1981; 90:186-189

9. Semenov SA: Prehistoric Technology. London, Cory, Adams and MacKay, Ltd, 1964, pp 13-15

10. Crabtree D: An Introduction to Flintworking. Pocatello, Idaho State University Press, 1972

11. Crabtree D, Butler D: Notes on experiments in flint-knapping—1: Heat treatment of silica materials. Tebiwa 1964; 7:1-6

12. Crabtree D: Notes on experiments in flint-knapping—3: The Flint-knapper's Raw Materials. Tebiwa 1967; 10:8-24

13. Crabtree D: A stoneworker's approach to analyzing and replicating the Lindenmeier folsom. Tebiwa 1966; 9:3-39

14. Crabtree D: Notes on experiments in flintknapping—4: Tools used for making flaked stone artifacts. Tebiwa 1967; 10:60-70

15. Crabtree D: Mesoamerican polyhedral cores and prismatic blades. Am Antiquity 1968; 33:446-478